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The Microscope in the Detection of Lard Adulterations.

By William T. Belfield, M. D., Chicago, Ill.

[PLATE.]

A recent investigation before the Chicago Board of Trade as to the purity of the lard sold by a large packing and provision company of that city, has extended the field of the microscope in its application to commerce, a problem which chemistry had long striven in vain to solve, and which it is, according to the sworn testimony of the ablest chemists in America, still unable to solve, has been demonstrated by the microscope.

The point in question is the recognition of a distinction between hog-fat and beef-fat. Chemists have long sought some method whereby lard could be distinguished from tallow, since the question of lard and tallow adulterations has repeatedly been a matter of great commercial moment. The only possible clue to a distinction between the two fats seemed to be the supposed difference in the relative proportions of stearine and oleine in the two; for it has been assumed that beef-fat contains more stearine than hog-fat. Several methods have been devised which were based upon this assumed difference; yet all have proved unsuccessful when put to a crucial test. This has been brilliantly illustrated during the recent investigation. A chemist who had sworn to his ability to detect the presence of tallow when mixed with lard, and who had testified to adulteration of certain specimens of lard because these specimens contained more stearine than he thought pure lard ought to contain, was required to examine five specimens of lard as to the composition of which he was ignorant. His analysis showed the utter worthlessness of the stearine test for tallow in lard, since he reported the discovery of tallow in two specimens, which were known to be pure

FIG. 2.

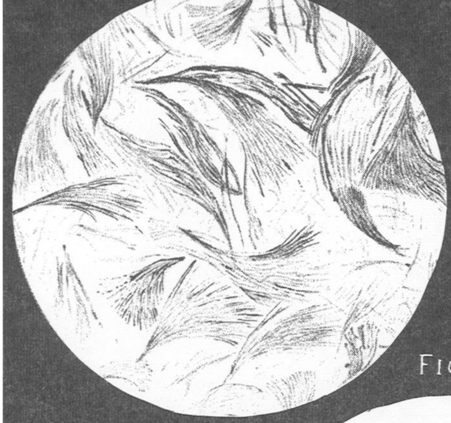


FIG. 1.

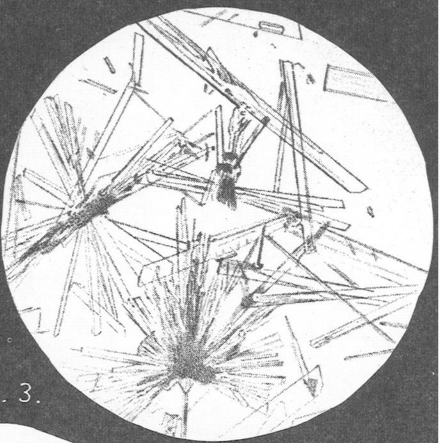


FIG. 3.

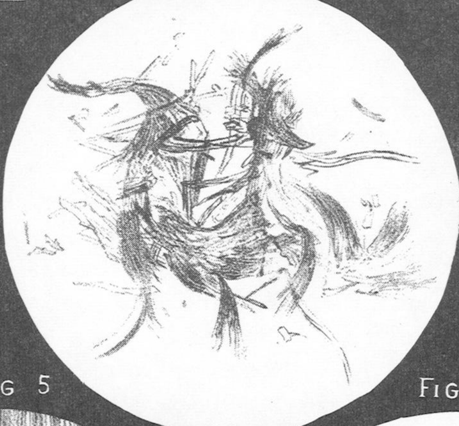


FIG 5

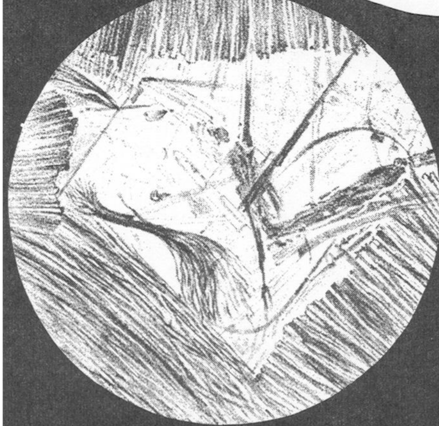
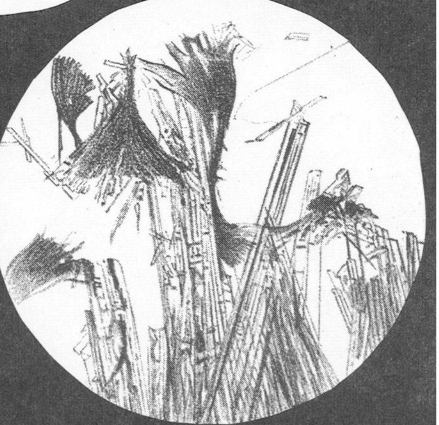


FIG. 4.



lard. Profs. Remsen, of Baltimore, Doremus and Habirshaw, of New York, Witthaus, of Buffalo, and Sharples, of Boston, all of whom testified upon the trial, stated that they knew no method whereby an adulteration of lard with tallow could be detected.

It was, therefore, especially gratifying when a demonstration was furnished that the microscope in the hands of a competent observer could accomplish the required task. This ability is based upon the fact that lard and tallow when dissolved in a volatile liquid, deposit upon standing, crystals which are characteristic of the respective fats, or, at least, serve to distinguish the one from the other. These crystals deposited from lard are so dissimilar from those obtained from tallow, that each can be distinguished in the presence of the other; hence it becomes possible to recognize a mixture of the two, and to detect an adulteration of lard with tallow.

This important fact was discovered some two years ago by Dr. P. B. Rose, of Chicago, while working in company with Dr. I. N. Danforth, of the same city. To these gentlemen belongs, therefore, the credit of a discovery, the value of which they do not seem to have recognized. At any rate they did not have occasion to make an exhaustive study of the possibilities contained in their discovery. The method employed by Dr. Rose for separating these crystals, consisted in dissolving the fats in turpentine and permitting the liquid to evaporate until crystals were deposited; these crystals were then examined in turpentine.

No especial application of this principle seems to have been made until the recent investigation before the Board of Trade began. It was charged that the lard in question was adulterated with tallow and with cotton-seed oil. The microscopical experts for the defense met Dr. Rose, by appointment, and were instructed by him as to the difference in these crystals and as to the method for preparing them. These gentlemen then devoted considerable time to the critical examination of the subject and found that the general statement made by Dr. Rose, as to the characteristic differences in the crystals, was correct. They differed as to the delicacy of the test, that is, as to the percentage of tallow adulteration that could be in this way detected; and their opinions were of a somewhat general nature since they had not submitted their ability to any critical test.

The writer was the only one of the experts engaged by the defense who was not present at the meeting at which Dr. Rose exhibited to the other microscopists his crystals of lard and tallow,and his methods for preparing them. Upon my return to the city a few days later I was engaged for the defense. I was at the same time informed that there were crystals characteristic of lard and tallow respectively according to Dr. Rose's statement; but I had no opportunity for inspecting the crystals, nor was I even informed as to their appearance.

Working thus independently I devised a method, which though involving the same general principle as that employed by Dr. Rose, differed in detail. It is perhaps only just to state that since the possibilities of this method have been developed, it has been adopted by the other gentlemen who formerly employed that of Dr. Rose.

The general plan is this: Ten grains of the fat—lard, tallow, or a mixture of the two—are dissolved in two drachms of Squibb's ether in a test-tube which is left open to the air. After a time—which varies, of course, with the temperature and hence with the consequent rapidity of evaporation—crystals are deposited at the bottom and on the sides of the tube. These may be examined at once in ether; but the field is apt to be obscured by numerous drops of oil. In order to remove these and thus to secure clean fields, it is advisable to pour off the supernatant liquid and to wash the crystals with clean ether. It may even be necessary to repeat this washing.

When pure lard is thus treated there will be found, upon examination of the deposit, thin rhomboidal plates, whose obtuse angles measure about one hundred and five degrees (Fig. 1). These plates vary extremely in size in the same specimen as well as on slides mounted from different test-tubes. This difference in size depends partly, at least upon the rapidity of evaporation. Sometimes these plates are arranged in rosettes, though this does not seem to be a necessary part of the arrangement.

When pure tallow is treated in precisely the same way, the crystals will be found not as rhomboidal plates, but in curved forms resembling in shape the italic letter *ſ* (Fig. 2 and 3). These crystals often appear singly and are also found grouped together so as to make a mass which may be roughly compared to a sheaf of wheat; at other times these masses have the same curved shape as the individual crystals, but seem constricted near the middle.

It is important to observe that these crystals are found when the tallow is treated by *the method above described.* For, if manipulated in other ways, tallow may furnish crystals which resemble somewhat closely those obtained from lard by this method. I have never seen rhomboidal plates deposited from pure tallow by my method, and examined in ether. Yet it is possible to secure such plates by permitting the ether to evaporate on the slide; in the part of the field which is already dry such plates may often be seen even when pure tallow is under examination.

The various admixtures of lard and tallow exhibit, when treated by this method, the characteristic crystals of both varieties, (Figs. 4 and 5). This is always true if the tallow amounts to, at least, twenty per cent. of the mixture; in smaller adulterations it is sometimes necessary to employ certain details which it is not necessary to describe here, in order to bring out the characteristic curved crystals of tallow. In these adulterations there appear numerous crystals, which seem to be modifications of the tallow crystals. These are somewhat fan-shaped, consisting of several spokes, or ribs, radiating from a common centre. In many cases the stem or handle of the fan is prolonged into a thin plate with a beveled end.

It is a matter of considerable importance to know just how delicate a test of adulteration this microscopic examination can be made; in other words, to know how small an admixture of tallow can be detected by the microscope. The opinion of the microscopists engaged in the trial on this point varied somewhat; the diversity of opinion depending, apparently, upon the experience of the observer, as well as upon the method used. All agreed that an adulteration in which the tallow amounted to twenty-five per cent. of the whole, could be readily and invariably detected; and all but one of the experts were confident that even a fifteen per cent. adulteration could be in like manner discovered. Up to the present time but two crucial tests on this point have been reported. One of these was embodied in my own evidence before the Board of Directors.

In order to demonstrate to myself the reliability of this method, I requested Dr. Tilley, one of my associates in the case, to prepare a series of samples which should contain pure lard as well as mixtures of lard and tallow. In compliance with this request Dr. Tilley kindly submitted to me nine samples, lettered A, B, C, etc., as to the composition of which I was utterly ignorant. After submitting these samples to microscopic examination, treating them by the method which I have already described, I reported to Dr. Tilley that five of the nine samples contained tallow, stating at the same time an approximate estimate of the percentage in each one of the five; the other four contained none of the crystals characteristic of tallow, so that I pronounced them free from this substance. In one of these four I detected something which was neithet lard nor tallow, but which I could not determine.

Dr. Tilley's memorandum, made at the time he prepared the samples in question, tallied precisely with my report, excepting some slight differences as to the percentage of the tallow in the adulterated specimens. I had detected the tallow in every specimen which contained it; and one of these five contained only *five per cent.* of tallow. The four which I had pronounced free from tallow were actually so; the one in which I had detected a substance which was neither tallow nor lard, proved to contain cotton-seed oil.

It will thus be seen that this test demonstrated, so far as it goes, that the microscope can detect any adulteration of lard with tallow when the latter amounts to five per cent. In other similar trials I have repeatedly shown my ability to detect ten per cent. adulterations; but as this was the only one in which a five per cent. mixture was presented to me, I do not, as yet, feel justified in asserting my ability to detect tallow in lard when the former is present in a proportion less than ten per cent. of the mixture.

The other test of the ability of a microscopist to detect adulterations of lard with tallow, was made at the instance of the Board of Directors. These gentlemen, in order to satisfy themselves as to the possibility of detecting such adulteration, submitted five samples to each of five gentlemen for examination. Four of these gentlemen were chemists, and all four demonstrated by their faulty analyses the unreliability of chemical methods. The fifth was a microscopist, a gentleman well known to this Society as an experienced and expert observer, Dr. Lester Curtis. Although the doctor had not previously given the subject of the analysis of fat much attention, he had the benefit of the information which had been presented in the evidence of the expert microscopists during the trial, and was furnished with several of my micro-photographs which were presented in evidence. At the end of a month Dr. Curtis presented the following report; the actual composition of the specimens is placed in the first column:

Number.	Actual Composition.	Dr. Curtis' Report.
1	Pure lard	Pure lard.
2	Pure lard	Pure lard.
3	85 per cent. lard and 15 per cent. tallow	Detected tallow.
4	85 per cent. lard and 15 per cent. cotton-seed oil	Doubtful.
5	80 per cent. lard, 10 per cent. tallow and 10 per cent. cotton-seed oil	Pure lard.

From this it will be seen that the doctor detected tallow when it constituted fiteen per cent. of the mixture, but over-looked it when present as only ten per cent. of the entire amount. It seems safe to assume that with a little more time and experience Dr. Curtis would have detected the adulteration in the latter sample also.

The figures on the accompanying plate are reproduced from micro-photographs presented in evidence to the Board of Directors; they represent a uniform amplification of two hundred and ten diameters.

Although the Board of Directors were, perhaps, not wholly impartial jurors, yet their verdict is interesting as showing their appreciation of the facts presented to them in evidence and in these micro-photographs. They say: "The Board of Directors would embrace this occasion to express their gratification that as the result of this investigation the question of ascertaining the truth as to adulterations in lard by scientific examination which has hitherto, to say the least, been one of extreme difficulty, seems now to give promise of a satisfactory solution; the board feels great encouragement to believe that even small adulterations with cotton-seed oil can be detected by some of the methods detailed in the evidence submitted in this case by scientific gentlemen; and that the microscope, in the hands of an experienced operator, can be successfully employed in detecting adulteration by beef product where it exists to the extent of ten, and probably even a much less percentage."